LEAVING CERTIFICATE EXAMINATION, 1981

APPLIED MATHEMATICS - ORDINARY LEVEL

WEDNESDAY, 24 JUNE - AFTERNOON, 2.00 to 4.30

Six questions to be answered.
All questions carry equal marks.
Mathematics tables may be obtained from the Superintendent.
Take the value of g to be 9·8 metres/second^2.

$\vec{i}$ and $\vec{j}$ are perpendicular unit vectors.

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1. Define uniform acceleration in a straight line. A particle starts from rest with uniform acceleration of 2 m/sec^2. After how many seconds will its speed be 30 km/hr ?

How far from its starting position will the particle be when its speed is 60 km/hr ?

The particle is then brought to rest in 2 metres. Calculate the deceleration.

2. A car of mass 1000 kg is freewheeling down an incline of 1 in 100. At an instant when its speed is 30 km/hr, brakes are applied and the car comes to rest after travelling a further 500 metres. Neglecting air resistance and assuming a constant braking force

(i) show in a clear diagram all forces acting on the system

(ii) calculate the deceleration of the car

(iii) calculate the braking force.

3. Two particles of masses 5 kg and 4 kg respectively are connected by a light inextensible string passing over a smooth, light, fixed pully. The particles are released from rest. Calculate

(i) the acceleration of the particles

(ii) the tension in the string.

If after two seconds the larger mass is caught and held, how much farther will the lighter mass rise ?

4. A uniform beam ab of length 4 metres and mass 20 kg stands with the end b on a horizontal floor and the end a against a vertical wall. The beam is in a plane perpendicular to the wall.

The coefficient of friction, μ, is the same at a and b.

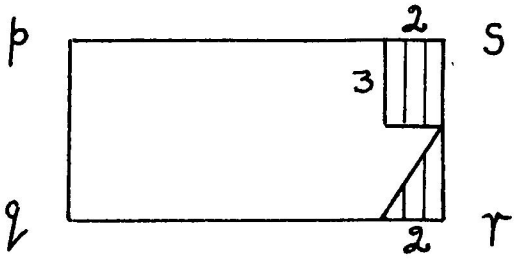
If the beam is on the point of slipping when its inclination is 45°, show that

$$\mu = \sqrt{2} - 1 .$$

5. (a) Particles weighing 3, 4, 5 and 6 newtons are placed on a horizontal plane at points $(-2\frac{1}{3}, 2)$, $(1,6)$, $(3,7)$ and $(4,-4)$ respectively.

Calculate the coordinates of the centre of gravity of the four-particle system.

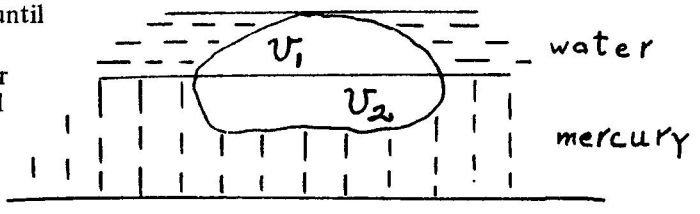
(b) $pqrs$ is a rectangular lamina $|pq| = 6$ cm and $|ps| = 10$ cm. Two pieces (both shaded), one rectangular and one triangular are cut off as shown in the diagram. Calculate the coordinates of the centre of gravity of the remaining portion, taking q as the origin.



6. (a) If the pressure 14 m below the surface of a fresh water lake is twice the pressure 2 m below the surface, calculate the atmospheric pressure in newtons per square metre. (density of fresh water = 1000 kg/m^3).

(b) A piece of steel floats on mercury in a dish. Water is added until the steel is just covered.

If the volume of steel in water is v_1 and the volume of steel under mercury is v_2 and the relative densities of steel and mercury are 7·8 and 13·6 respectively, calculate the ratio $\frac{v_1}{v_2}$.



7. A projectile is fired from a cliff edge with an initial speed of 180 m/s at an angle of elevation of 30°. The edge of the cliff is 150 m above level ground. Calculate

(i) the greatest height above level ground reached by the projectile

and (ii) the time taken to reach level ground.

8. State the principal of conservation of energy.

A smooth circular wire, radius a, is fixed in a vertical plane. A small ring, mass m, threaded on the wire is projected from its lowest point with speed u given by $u^2 = 2ga$ (g = gravitational acceleration).

Calculate

(i) the total energy at the instant of projection

(ii) the greatest height reached by the ring

(iii) the speed of the ring on reaching a height equal to half the greatest height.

9. A railway engine, E, of mass 18000 kg is travelling due north at a speed of 0·6 m/s on a straight stretch of track when it collides with a stationary engine, G, mass 30000 kg. The collision causes G to move due north at a speed of 0·36 m/s.

Calculate

(i) the velocity of E after the collision

(ii) the value of the coefficient of restitution

(iii) the power required to bring G to rest after 10 seconds.